

## NOTES ON THE BIOLOGY OF SOME QUEENSLAND FLIES.

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(With 48 Text-figures.)

DURING our experimental work with Diptera as possible transmitting agents of certain worm parasites of horses and stock<sup>1</sup> we used a number of species of flies found associated with these animals, some of them being either insufficiently described or apparently undescribed. We have already dealt with a few of these flies (Johnston and Bancroft, 1919) and now propose to give an account of certain others which, as far as available literature allows us to judge, belong to undescribed species of *Musca*.<sup>2</sup>

We desire to express our appreciation of the assistance given by Dr. E. W. Ferguson, Health Department, Sydney; Mr. W. W. Froggatt, Government Entomologist, Sydney; Dr. A. B. Walkom, Linnean Society, Sydney; and Mr. W. A. Rainbow, Australian Museum, Sydney. Typical specimens have been deposited in the Queensland Museum, Brisbane, and in the Australian Museum, Sydney.

### MUSCA TERRÆ-REGINÆ n. sp.

(Text-figs. 1, 2, 9, 10, 15, 17, 18, 27, 28, 31, 37, 38, 41, 42, 43, 44, 45.)

This is a rather small fly about 4.5 mm. in length, which has been taken occasionally on stock in the Eidsvold district and is referred to in our previous paper (1919, p. 182) as *Musca* sp. indct.

#### MALE.

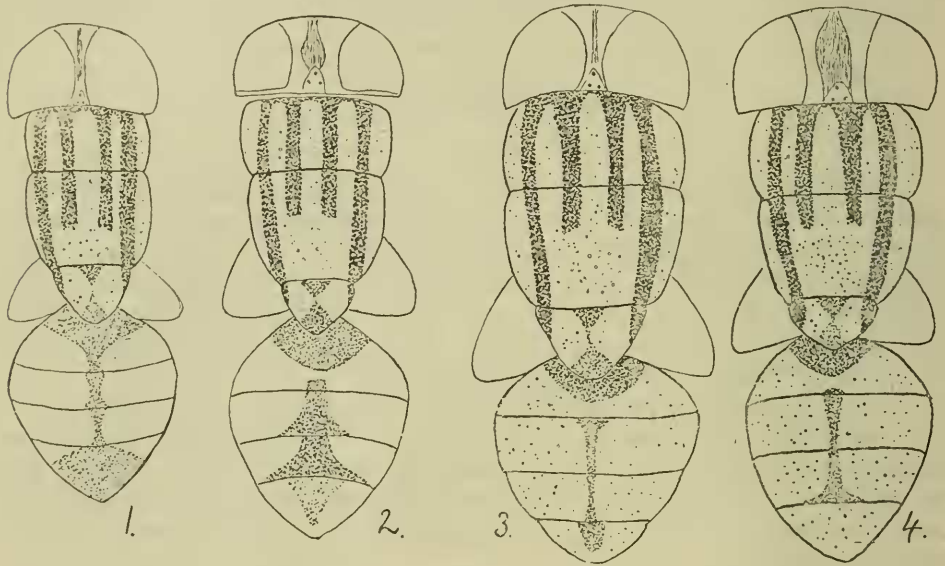
*Head* (fig. 9).—One is struck with the relatively enormous size of the eyes which occupy more than three quarters of the front of the head. They are separated from one another by a narrow frontal stripe bounded by numerous

<sup>1</sup> Johnston and Bancroft, The Life History of *Habronema* in relation to *Musca domestica* and native flies in Queensland, P.R.S. Q'land, 1920.

Johnston and Bancroft, Experiments with certain Diptera as possible transmitters of bovine *Onchocerciasis*, P.R.S. Q'land, 1920.

<sup>2</sup> Unfortunately for us Professor M. Bezzi's excellent key deals only with African and Mediterranean species of *Musca* (*Miodarii Superiori* raccolti dal Sign. C. W. Howard nell Africa australe orientale—Boll. Lab. zool. gen. agr. d. R. Scuola Sup. d'Agric. Portici, 6, 1912, Keys pp. 85-88).

rather short chaetae. The ocellar triangle is not very prominent and bears about four pairs of short ocellar bristles. Behind the triangle there is on each side a prominent vertical bristle, with a shorter one adjacent to it. The facial region is practically triangular in outline. The silvery parafrontals do not extend upwards between the eyes except as a thin black line on either side between the frontal stripe and each eye. The characters of the silvery-grey antennae are shewn in fig. 31.



Text-figs. 1-4.—*Camera lucida* drawings to show dorsal colouration. All figs. drawn to same scale. Fig. 1, *Musca terra-reginae* male; 2, *M. terra-reginae* female; 3, *M. hilli* male; 4, *M. hilli* female.

*Thorax* (fig. 1).—When viewed with the light falling from the front the thorax is black and shiny, but when viewed from the opposite quarter the general effect is dark greyish.<sup>3</sup> There are four longitudinal stripes, the two outer extending backwards to the sides of the scutellum whilst the two inner extend only to the middle of the scutum. The central silver-grey stripe is rather broader and in individuals of either sex may extend much further forward than the others. The black stripes of each side fuse anteriorly. The posterior half of the midregion of the scutum is rather darker than the other portions. On the anterior part of the scutellum there is a prominent black marking followed by a well-defined smoky patch extending to the hind margin of the scutellum. The chaetotaxy is shewn in fig. 15.

<sup>3</sup> The accompanying descriptions of the thorax and abdomen of each species are based on specimens with the head towards the observer and with the source of light opposite the observer.

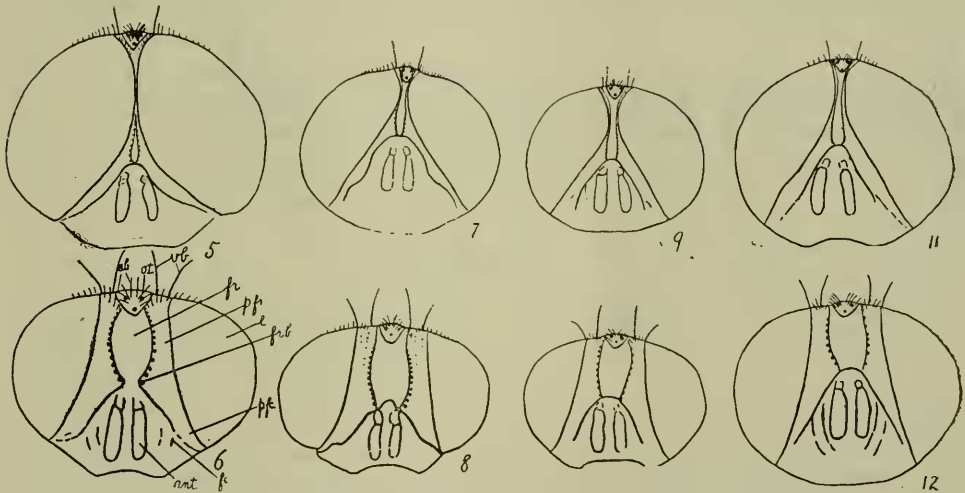
*Wings.*—The veins are yellowish brown. The venation is shewn in fig. 17. The squame is pale yellow.

*Legs.*—The tarsus of the third leg is figured in fig. 27.

*Abdomen.*—The abdomen is pale yellow with a median dorsal band, the intensity of whose colouration is interrupted in places so that there appears a succession of light-brown and dark-brown markings. The colouration extends to the anterior half of the first abdominal segment<sup>4</sup> where it is rather dark brown. Laterally on each segment there is a patch of darker yellow (fig. 1).

FEMALE.

*Head.*—The main external difference between the male and female is in the size of the eyes which in the female are separated (where they most closely approximate) by about a third of the width of the head (fig. 10), whereas the minimum distance is about one twenty-fifth in the male. The silvery parafrontals extend upwards between the eyes as a fairly broad band separated by



Text-figs. 5-8.—*Camera lucida* outlines of face views drawn to same scale to show relationship of eyes, frons, etc. Fig. 5, *M. australis* male; 6, *M. australis* female; 7, *M. vetustissima* male; 8, *M. vetustissima* female; 9, *M. terræ-reginæ* male; 10, *M. terræ-reginæ* female; 11, *M. hilli* male; 12, *M. hilli* female. Lettering as in preceding figures—*ant.*, antenna; *e.*, eye; *fr.*, frons or frontal stripe; *fr.b.*, frontal bristles; *fc.*, facialia; *o.b.*, ocellar bristle; *o.t.*, ocellar triangle; *p.fc.*, parafacialia; *p.fr.*, parafrontalia; *v.b.*, vertical bristles.

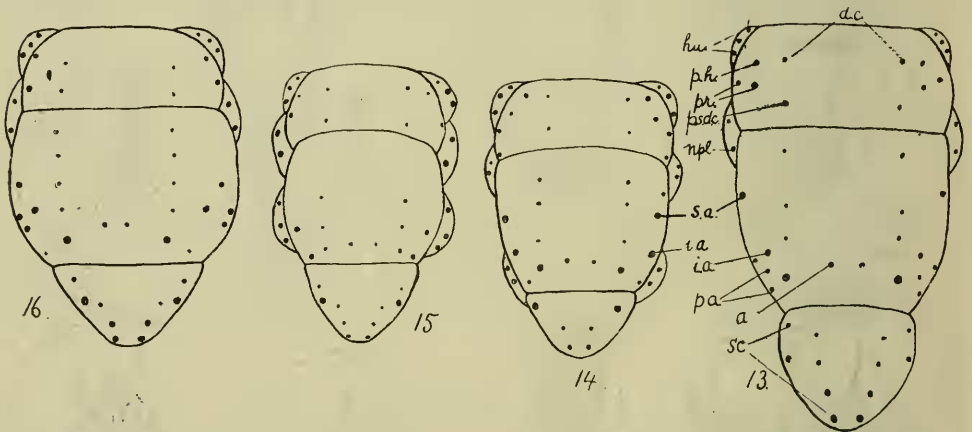
the very shallow smoky-coloured frontal stripe. There are two prominent vertical bristles on either side behind the eyes. The ocellar triangle does not project and the ocellar bristles are short.

<sup>4</sup> The terms 1st to 4th are applied to the obvious abdominal segments—*i.e.*, the reduced first segment is not taken into account as a separate one but is considered as a part of the second with which it is fused, the two together being dealt with as the first segment.

*Thorax.*—The thorax is similar to that of the male (fig. 2). The form of the last tarsus is shown in fig. 28.

*Wings.*—As in the case of *M. hilli* there are slight differences in the sexes in regard to the wing, particularly in the region of the first posterior cell and the posterior cross-vein (fig. 18).

*Abdomen* (fig. 2).—The general colour is yellow with a brown median dorsal stripe, rather broad on the anterior portion of the first segment and more or less interrupted in the middle portion, but on the posterior region of that segment the colouration makes its reappearance extending on to the succeeding segment and widening to form a large dark-brown blotch of more or less triangular outline. A similar patch of colour occurs on the succeeding segment and is continued on to the fourth. Faint shimmering whitish patches occur laterally towards the posterior end of the abdomen. The under surface is yellow.



Text-fig. 13, Outlines of thorax (dorsal) to show chaetotaxy; *M. australis*; 14, *M. vetustissima*; 15, *M. terre-reginae*; 16, *M. hilli*. Lettering—*a.*, acrostichal (inner dorso-central); *d.c.*, dorsocentral; *hu.*, humeral; *i.a.*, intra-alar; *npl.*, notopleural; *pa.*, postalar; *p.h.* posthumeral; *pr.*, presutural; *p.s.d.c.*, presutural dorsocentral; *s.a.*, supra-alar; *sc.*, scutellar.

*Breeding Habits.*—The eggs are laid in cowdung or horsedung, each egg measuring about 1 mm. in length by .25 mm. in breadth, being very similar to that of the house-fly. In less than twenty-four hours the eggs hatch, the larvæ being in the first instar (fig. 42). Twenty-four hours later the first moult occurs; the anterior spiracles each with six or seven processes appear (fig. 45), while the posterior spiracles are in the form of two almost straight slits (fig. 43). The second instar also lasts about twenty-four hours. In the third instar the posterior spiracles take the form of three sinuous slits surrounded by a black chitinous D-shaped ring (fig. 44). The mature larvæ are creamy white and measure 9 to 10 mm. in length by 1.5 mm. in breadth. They leave the dung

and pupate in damp sand under laboratory conditions. The puparium is reddish brown and measures 4 to 5 mm. by 1.5 to 2 mm. The larval stage lasts from 5 to 7 days, and the pupal from 7 to 10 days, the total thus being from 12 to 17 days during midsummer (Eidsvold, Burnett River), which is similar to that of the house-fly.

In bred flies the males were usually slightly in excess of the females, about 51 per cent. being males and 49 per cent. females. When bred flies of both sexes were kept together in a small cage and fed on raisins, honey, &c., copulation was observed to take place in from 5 to 9 days after emergence (midsummer observations), while the females were ready to oviposit about five days later.

The female genitalia (fig. 41) closely resemble those of the house-fly, except that the number of ovarian follicles is less, the maximum number detected in each ovary being thirty-five.

*Parasites.*—*M. terre-reginæ* was found to be parasitised by a flagellate, *Herpetomonas* (probably *H. muscæ-domesticæ* Burnett), and by three larval nematodes (*Habronema muscæ* Carter, *H. megastoma* Rud, and *Agamospirura muscarum* Justn. and Baner.).

The following observation may be of interest as it allows one to compare the various periods taken by the three flies *M. terre-reginæ*, *M. vetustissima*, and *M. domestica* to pass through their larval stages in horsedung, since all were under similar conditions, being bred in material from the same source and collected at the same time (November, 1919, Eidsvold) :—

—	<i>Musca terre-reginæ.</i>	<i>M. vetustissima.</i>	<i>M. domestica.</i>
Eggs deposited .. ..	November 13th .. ..	14th .. ..	14th .. ..
Hatched as first instar	November 14th .. ..	15th .. ..	15th .. ..
Second instar .. ..	November 15th .. ..	15th and 16th ..	16th .. ..
Third instar .. ..	November 16th, 17th ..	17th .. ..	17th .. ..
Mature larva .. ..	November 18th, 19th, and 20th	18th and 19th ..	20th and 21st
Larval stages .. ..	5 to 7 days .. ..	4 to 5 days .. ..	6 to 7 days
Emergence—			
25.11.9 .. ..	.. ..	2 males, 2 females	.. ..
26.11.9 .. ..	.. ..	2 males, 5 females	.. ..
27.11.9 .. ..	2 males, 3 females .. ..	9 males, 2 females	.. ..
28.11.9 .. ..	Few—both sexes .. ..	.. ..	.. ..
29.11.9 .. ..	Few—both sexes .. ..	.. ..	A few
30.11.9 .. ..	1 male, several females ..	.. ..	A few
Pupal stage .. ..	8 to 11 days .. ..	7 to 9 days .. ..	9 to 10 days
Total period for larval stages (egg to imago) approximately	13 to 18 days .. ..	11 to 11 days ..	15 to 17 days

**MUSCA HILLI** n. sp.

(Text-figs. 3, 4, 11, 12, 16, 19, 20, 29, 30, 32, 39, 40, 46, 47, 48.)

This is an outdoor species which is occasionally found on horses and cattle in Eidsvold and also in Brisbane. We have also seen it at Tweed Heads, N. S. Wales (Mareh, 1920). The average length of full-grown specimens of either sex is about 6 mm.

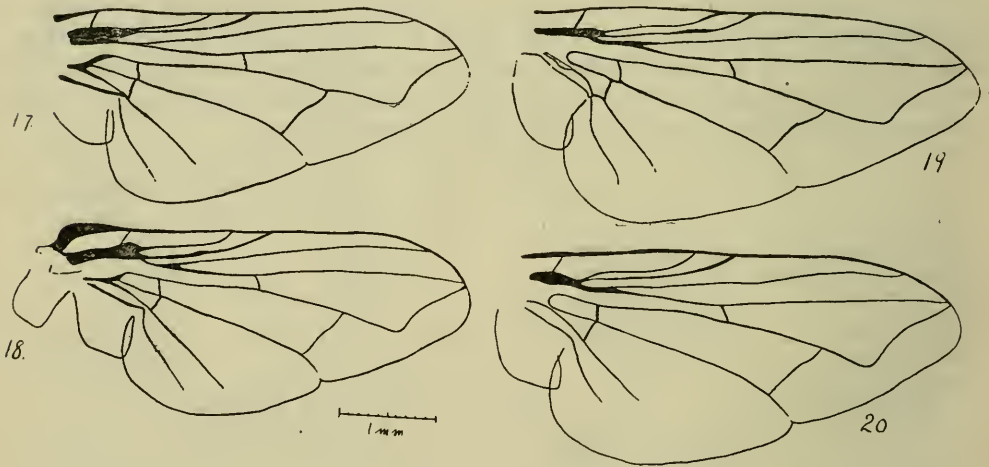


## MALE.

*Head.*—The eyes occupy the greater part of the front view and are contiguous for a considerable distance (fig. 11), separated only by a very narrow frontal stripe. The ocellar triangle is elongate and narrow, projects prominently, and bears about four pairs of ocellar bristles. The parafrontals are wide and silvery. The frontal stripe is narrow and brownish.

The antennæ are smoky in colour. The form of the arista is shewn in fig. 32. There are two prominent bristles, also a shorter third one, on the second joint of the antenna.

*Thorax* (fig. 3).—When lighted from the anterior end the general effect is black and shiny, but when viewed from the opposite quarter four distinct stripes are to be seen separated by narrow greyish zones. The outer stripes extend from the anterior portion of the thorax to the end of the scutum and on to the anterior corners of the scutellum. The two inner stripes extend from the anterior end of the prescutum to about the midregion of the scutum where they merge into a rather smoky colouration occupying the middle and posterior



Text-fig. 17, Wings drawn to same scale; *M. terræ-reginæ* male; 18, *M. terræ-reginæ* female; 19, *M. hilli* male; 20, *H. hilli* female.

part of the scutum between the longitudinal stripes. The four stripes are of approximately equal width and are each rather narrower than the central silvery stripe. The two dark stripes of each side are joined up by a black band anteriorly, somewhat as in *M. fergusonii*. The posterior end of the scutellum is smoky, this colouration becoming intensified so that at the anterior end the scutellum is practically black. The chaetotaxy is indicated in fig. 16. It might be mentioned that the scutellum is very hairy, the setæ being particularly well developed and the macrochaetæ quite long,

*Wings.*—The wings are clear, the veins yellowish brown. The venation

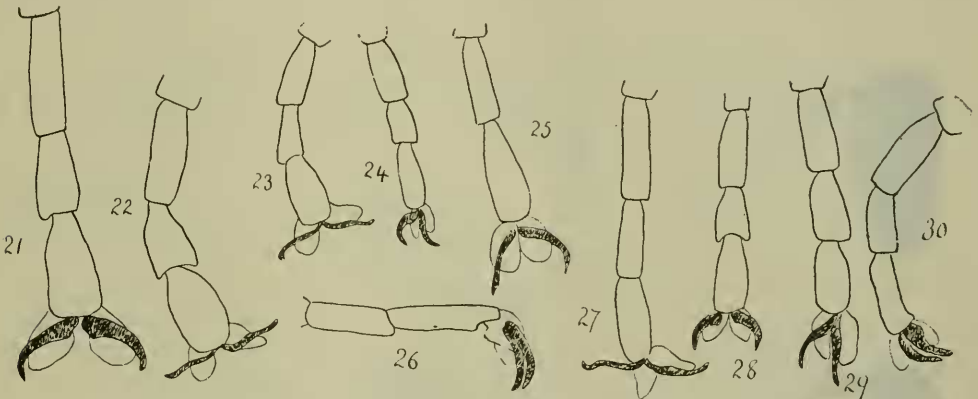
is indicated in fig. 19. To the naked eye the squame appears opaque and somewhat pearly.

*Legs.*—The characters of the tarsi of the third leg are shewn in fig. 29.

*Abdomen (fig. 3).*—The fly can be very readily distinguished from *M. vetustissima* and *M. fergusonii* by the pale-yellow abdomen in both sexes. There is dorsally a median narrow brownish stripe, interrupted in the middle of the first abdominal segment. It is more pronounced in some individuals than in others, being occasionally reduced to a brownish blotch on the posterior edge of each segment. Whitish reflections are visible posteriorly and postero-laterally. The abdomen is well provided with long chaetae. The ventral surface is pale yellow with brownish colouration in the vicinity of the genital aperture.

#### FEMALE.

*Head (fig. 12).*—The head of the female differs from that of the male in the following particulars:—The eyes are widely separated, the distance between them, where they approach most nearly, being about a third of the total width



Text-fig. 21, Tarsi of third leg—final segments only—all drawn to same scale, *M. australis* male; 22, *M. australis* female; 23, *M. vetustissima* male; 24, *M. vetustissima* female; 25, *M. domestica* male (for comparison); 26, *M. domestica* female; 27, *M. terra-reginae* male; 28, *M. terra-reginae* female; 29, *M. hilli* male; 30, *M. hilli* female.

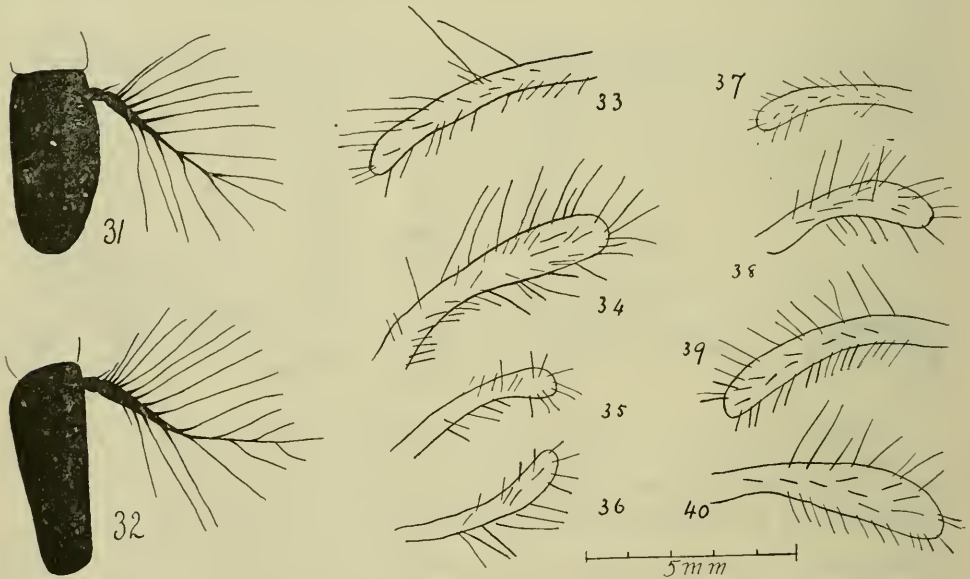
of the head, whereas in the case of the male it is about one thirtieth. There is a broad shallow dusky frontal stripe bounded by strongly incurving fronto-orbital bristles. On each side of the stripe is a fairly wide parafrontal which, as in the case of the male, is silvery.

*Thorax (fig. 4).*—The female thorax has much the same characters as the male.

*Wing.*—The wing (fig. 20) differs from that of the male in the shape of the first posterior cell (fifth radial) and also in the form of the elbow of the fourth longitudinal vein ( $M. 1 + 2$ ) and its relation to the posterior cross-vein (mediocubital).

*Abdomen (fig. 4).*—When viewed from certain points the abdomen appears to possess shimmering white patches, this being of course due to the arrangement of the tiny hairs. Ventrally the colour is pale yellow, there being only a faint brownish tint around the genital opening.

*Breeding Habits.*—The breeding habits of this fly resemble those of the preceding species, the small white eggs, which measure approximately the same as those of *M. terra-reginæ*, being laid in cowdung or horsedung. The successive instars occupy about the same periods. The posterior spiracles of the second and third instars are quite typical (figs. 46, 47). The anterior spiracles contain from 4 to 7 processes (fig. 48). The mature larva measures from 10 to 12 mm. The larval stage occupies from 5 to 6 days, the pupal 6 to 9 days—a total of 11 to 15 days (January and February, Eidsvold and Brisbane). The puparium is red-brown to deep chocolate and measures about 6 mm. in length by 2.7 mm. in breadth. The female genitalia are very like those of the preceding species (fig. 41), the maximum number of follicles observed in each ovary being, however, slightly larger, viz., about 40.

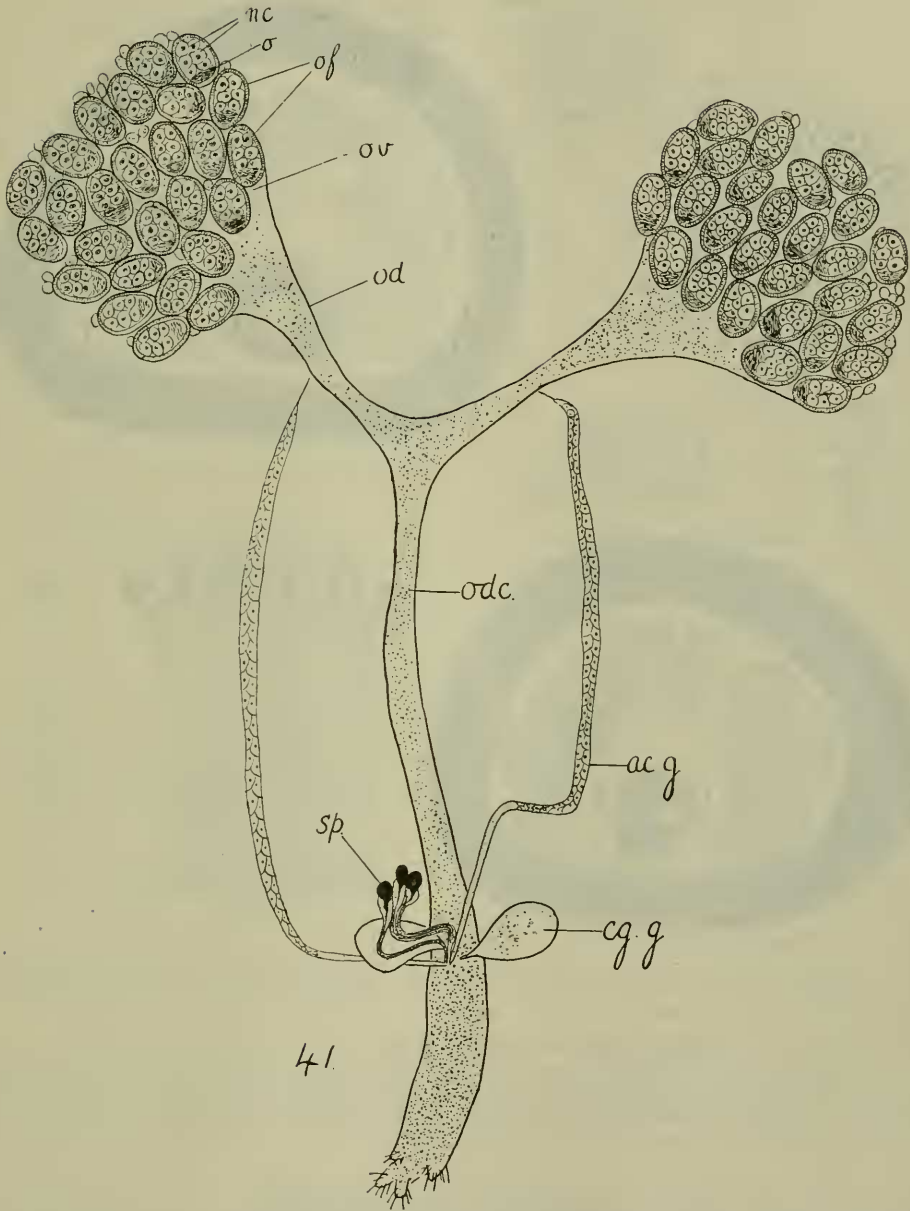


Text-fig. 31, *Aristæ* of females, *M. terra-reginæ*; 32, *M. hilli*.

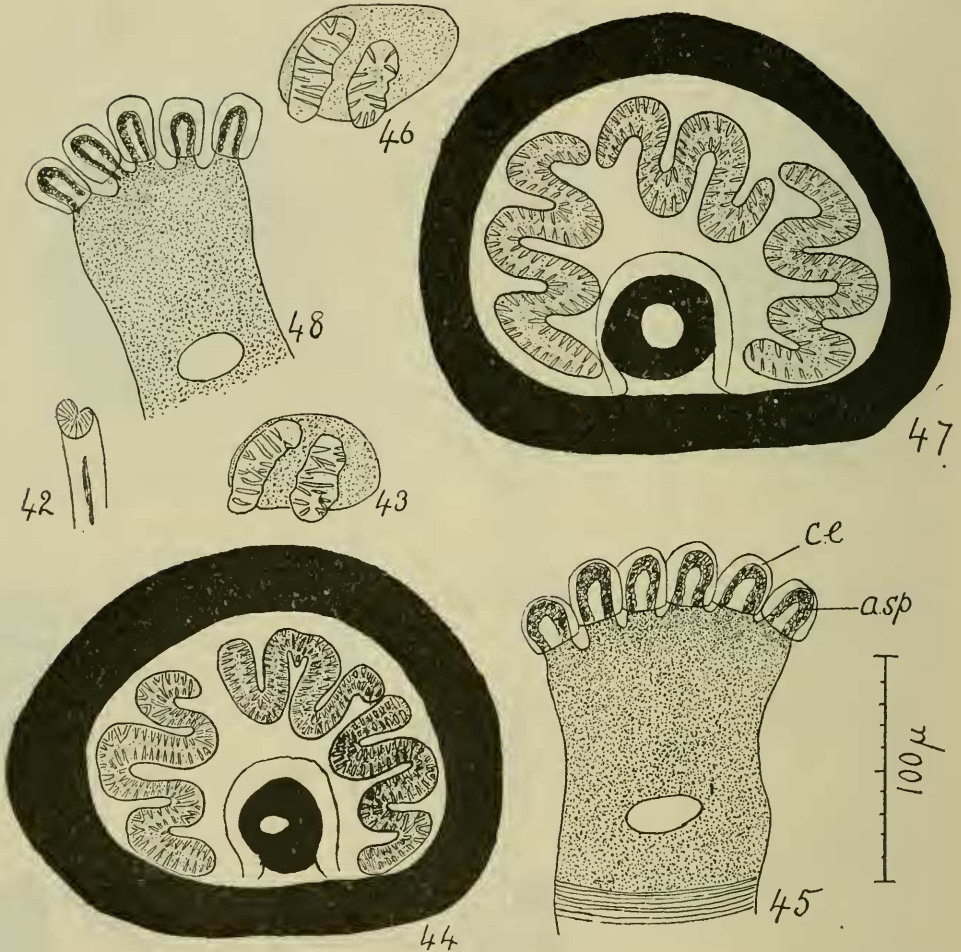
Text-fig. 32, Palps (all to same scale) drawn from mounted specimens, *M. australis* male (fig. 33) and female (34); *M. vetustissima* male (fig. 35) and female (fig. 36); *M. terra-reginæ* male (fig. 37) and female (fig. 38); *M. hilli* male (fig. 39) and female (fig. 40).

The fly can be readily distinguished from *Musca pumila* by the colouration of its abdomen (Macquart, Dipt. Exot. Suppl. 3, 1847, p. 58). It appears to be more closely related to *Musca minor* (Macquart, l.c. Suppl. 4, 1850, p. 253).





Text-fig. 41, Genitalia of female *M. terra-reginae*. Lettering: *ac.g.*, accessory gland; *c.g.g.*, conglobate gland; *nc.*, nurse cells; *o.*, ovum; *od.*, oviduct; *od.c.*, common oviduct; *of.*, ovarian follicles; *ov.*, ovary; *sp.*, spermatheca.



Text-figs. 42-44, Larval spiracles, all drawn to same scale. Posterior spiracles of *M. terra-reginae*; first instar (42), second instar (43), third instar (44).

Text-fig. 45, Anterior spiracle of third instar of *M. terra-reginae*.

Text-figs. 46-48, Spiracles of larva of *M. hilli*: fig. 46, posterior spiracle of second instar; 47, posterior spiracle of third instar; 48, anterior spiracle of third instar. *a.sp.*, anterior spiracular process, surrounded by a clear envelope (*c.e.*).

from Tasmania, but in view of the brevity of the description, particularly in regard to the thoracic and abdominal markings, we do not feel justified in identifying our form with his. We have pleasure in associating with this new species the name of Mr. G. F. Hill, Entomologist to the Australasian Institute of Tropical Medicine, Townsville, North Queensland, who has published important papers dealing with Australian flies.

*Parasites*.—*M. hilli* readily becomes parasitised by the nematodes *Habronema muscae* and *H. megastoma*.

### **EUMUSCA VETUSTISSIMA** (Walker).

(Text-figs. 7, 8, 14, 23, 24, 35, 36.)

Townsend (1915) stated that the type of the genus *Musca*—so designated by Latreille—is *M. vomitoria* L., a blowfly which was transferred to *Calliphora*; and that the latter generic name fell into synonymy, a new name being required for the species usually placed under *Musca*. He accordingly erected the genus *Promusca* (p. 434) with *M. domestica* L. as its genotype. He had previously (1911, p. 170) separated off certain species making *M. corvina* Fabr. the type of *Eumusca*.

The characters of *Musca vetustissima*, which have already been described by us (J. and B., 1919), agree with most of those given by Townsend (1915, p. 435) but differ in certain important respects—*c.g.*, (1) the eggs, though macrotype, are not stalked; (2) the puparium is red-brown like that of the house-fly; and (3) copulatory vesicles are present in the female. The species thus occupies a position between *Promusca* and *Eumusca*, more nearly approaching the latter genus of which it may perhaps be regarded as an atypical member, otherwise a new genus would need to be erected for its reception.

In our previous account we did not refer to the chaetotaxy which is now figured (fig. 14). There are two weak dorsocentrals on either side in front of the suture. The presutural and posthumeral are rather strongly developed. Postsuturally there are four dorsocentrals, only the last being strong. Three pairs of scutellar macrochaetae are present, two pairs being well developed. The vertical bristles behind the eyes are arranged as in *Musca domestica*.

The palp of the two sexes are shown in figs. 35 and 36 and the tarsus of the third leg in figs. 23 and 24.

In our earlier account (1919, fig. 5) we omitted to indicate in our figure that the fourth abdominal segment (*i.e.* true fifth) of the male possessed a dark colouration.

Dr. Cumpston, Director of the Federal Quarantine Service, informed us that he had observed the common Western Australian bush-fly (*M. vetustissima*) copulating thirty-six hours after emergence. He used a rather large cage measuring about 6 by 6 by 8 feet for his observations.

### **VIVIPAROMUSCA FERGUSONI** J. and B.

(Text-figs. 5, 6, 13, 21, 22, 33, 34.)

This species was described last year (J. and B.) as *Musca fergusonii*. If Townsend's genus *Viviparomusca* (1915, p. 435) be recognised then the relationships of this Northern Australian fly are rather with it than with *Promusca*.

(*Musca* of authors). It differs, however, in several important points, viz.—(1) the larva is carried in the uterus to the *second* stage, not the third; (2) copulatory vesicles are present in addition to the accessory glands in the female. In regard to (1) we might point out that the two posterior spiracular slits of this instar are not straight but sinuous as they are in those of the third instar where there are three. Then again in the type species of the genus *M. bezzii* Patton, a larva is deposited, though in which stage mention is not made by Patton and Cragg (1913, p. 23). In *M. fergusonii* the larva is deposited while in an eggshell which at once bursts liberating it.

This fly appears to be very hairy on account of the presence of well-developed macrochætæ on the dorsal part of the thorax. Many of the scutellar bristles are very strong and are practically macrochætæ. The arrangement is shown in fig. 13. The vertical pairs between the eyes are strong. The ocellar bristles are weakly developed in both sexes, especially in the male where they are practically absent.

The form of the tarsi and claws of the third leg in the two sexes is shown in figs. 21 and 22. The palps bear very strong setæ in both sexes, especially in the male (figs. 33, 34).

#### OTHER FLIES.

In our earlier paper (1919, p. 182) we referred to the presence of certain other flies in the Eidsvold district. The cobalt-blue species therein indicated as *Lasiopyrellia* is a *Pseudopyrellia*, according to Williston's Key to the North American genera (1908), while the very small fly which was regarded as being probably a *Pseudopyrellia* falls within the genus *Pyrellia*. It was mentioned that both of these metallic flies frequented cowdung for oviposition. So also does a rather handsome large blowfly which Mr. W. W. Froggatt has identified for us as *Stenopterina gigas* Macq. A tiny species of *Sepsis* is very commonly found frequenting similar material and breeds in it. Patton and Cragg (1913b, p. 310) refer to its presence in India.

*Muscina stabulans* has been bred out of rotting potatoes received at Eidsvold from elsewhere and no doubt the fly is occasionally to be met with in the township.

Amongst the Anthomyidæ occurring there one might mention that *Phaonia personata* Walker, which at first sight somewhat resembles a large greyish or bluish long-winged house-fly, is to be found in the vicinity of rotting fruit and has been bred out from that material.<sup>5</sup> Mr. Froggatt (1907, p. 311) who kindly identified the species and also the one next mentioned, informed us that it occurred commonly in fruit-shops in Sydney. *Sapromyza fuscicornis* Macq., a fairly large fly (Sapromyzidæ) with a striped thorax and a dark head, has been bred from horsedung (Eidsvold).

<sup>5</sup> See also W. B. Gurney. Fruit-flies and other insects attacking cultivated and wild fruits in N. S. Wales—Farmers' Bulletin, No. 55, July, 1912, Dept. Agric. N. S. Wales, p. 29; and in Agric. Gaz. N. S. Wales, January 1912 (pp. 75-80).



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